Supporting Information for

Impact of large-scale greening on surface temperature: a case study in the Kubuqi Desert, Inner Mongolia based on the WRF model

Text S1.

Mathematical details of the IBPM theory

Eq. (1) in the article is generated from the energy balance equation:

$$R_n = S + L_{\downarrow} - \sigma T_s^4 = LE + H + G \quad \text{(S1)}$$

Then

$$R_n^* = LE + H + G + \sigma T_s^4 - \sigma T_a^4 \quad \text{(S2)}$$

According to the Taylor expansion and omitting higher order terms, we have

$$T_s^4 - T_a^4 \approx 4T_s^3(T_s - T_a) \quad \text{(S3)}$$

The latent heat (*LE*) and sensible heat (*H*) can be described as:

$$LE = H/\beta \quad \text{(S4)}$$

$$H = \rho C_p \frac{T_s - T_a}{r_t} \quad \text{(S5)}$$

Eq. (S2) becomes

$$R_n^* - G = \rho C_p \frac{T_s - T_a}{r_t \beta} + \rho C_p \frac{T_s - T_a}{r_t} + \sigma 4T_s^3(T_s - T_a) \quad \text{(S6)}$$

The energy redistribution factor *f* is given by:

$$f = \frac{\rho C_p}{4 r_t \sigma T_s^3}\left(1 + \frac{1}{\beta}\right) \quad \text{(S7)}$$

Finally, we obtain

$$T_s - T_a = \frac{\lambda_0}{1+f}(R_n^* - G) \quad \text{(S8)}$$

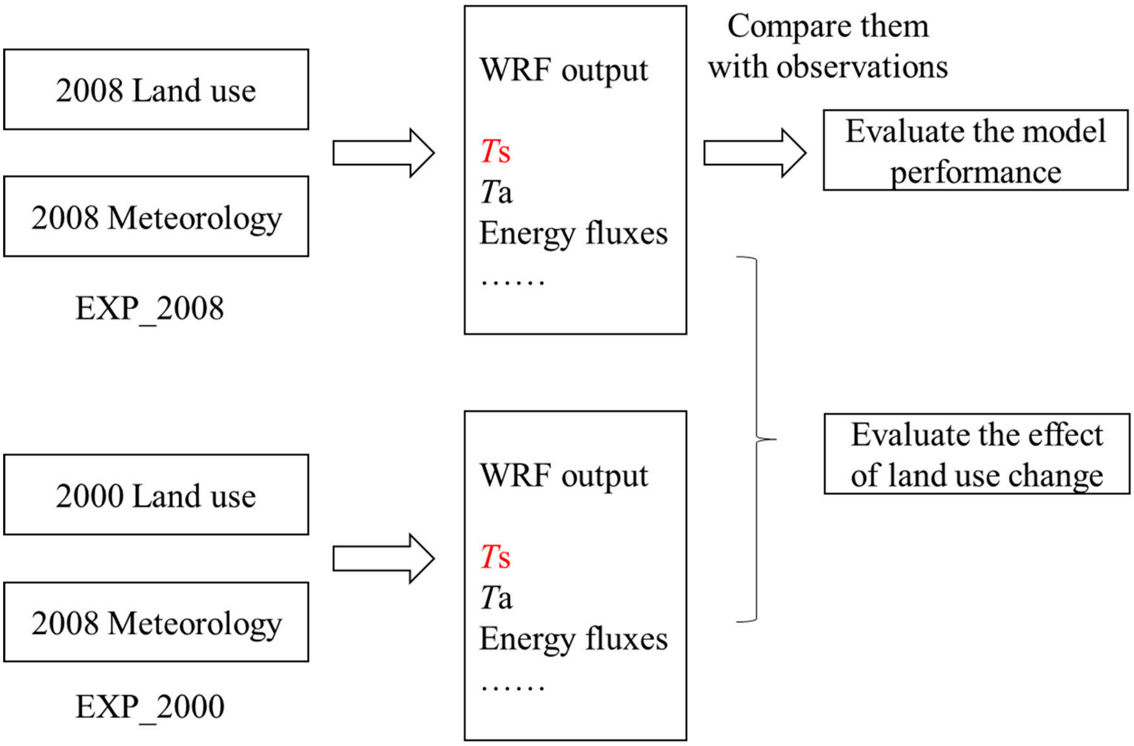

Figure S1. The experimental design of the two simulations.

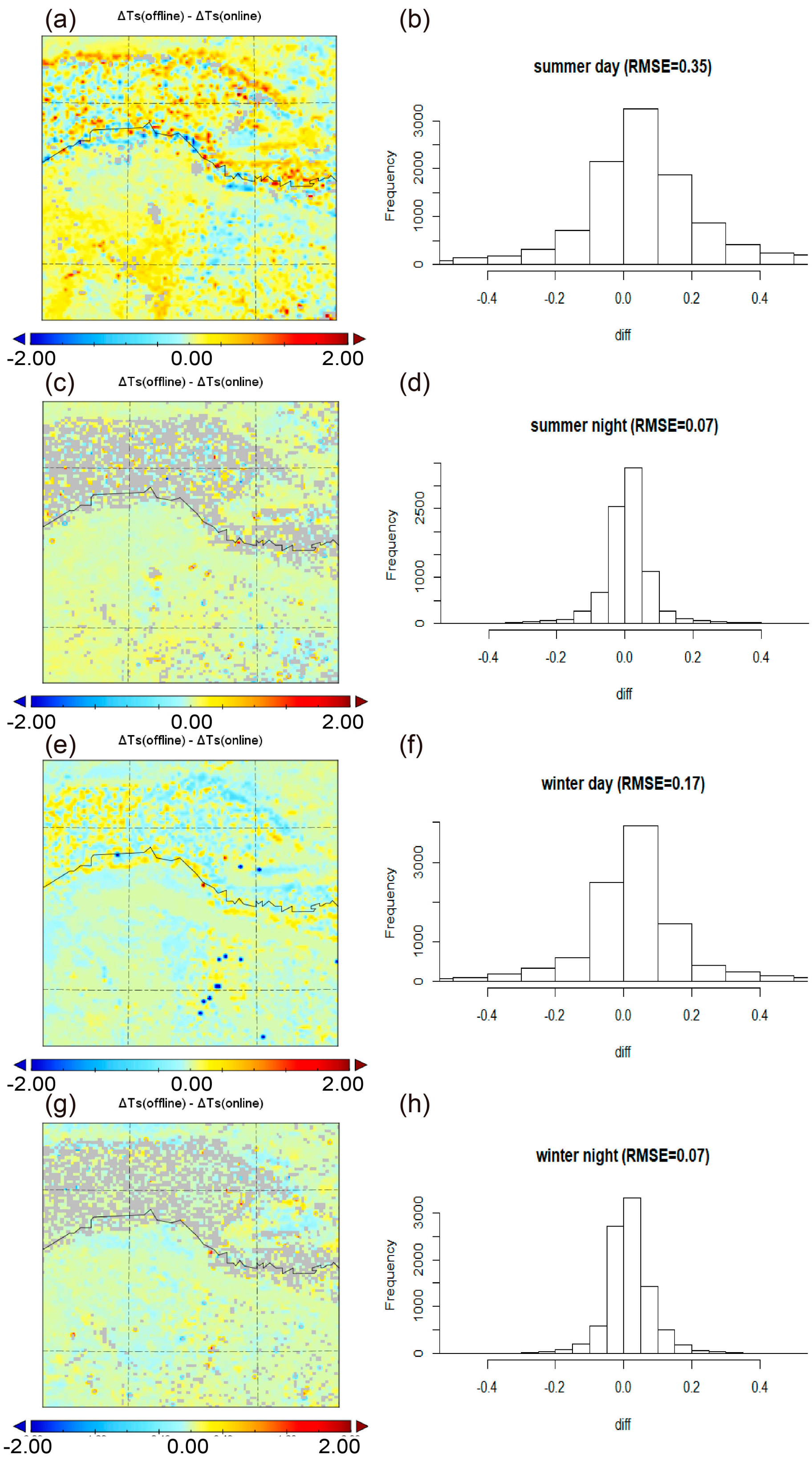

Figure S2. The difference between online and offline ΔT_s. (a), (c), (e) and (g) represent the results of summer daytime, summer nighttime, winter daytime and winter nighttime, respectively. The x-axis of the hist plots is the difference between offline ΔT_s and online ΔT_s.

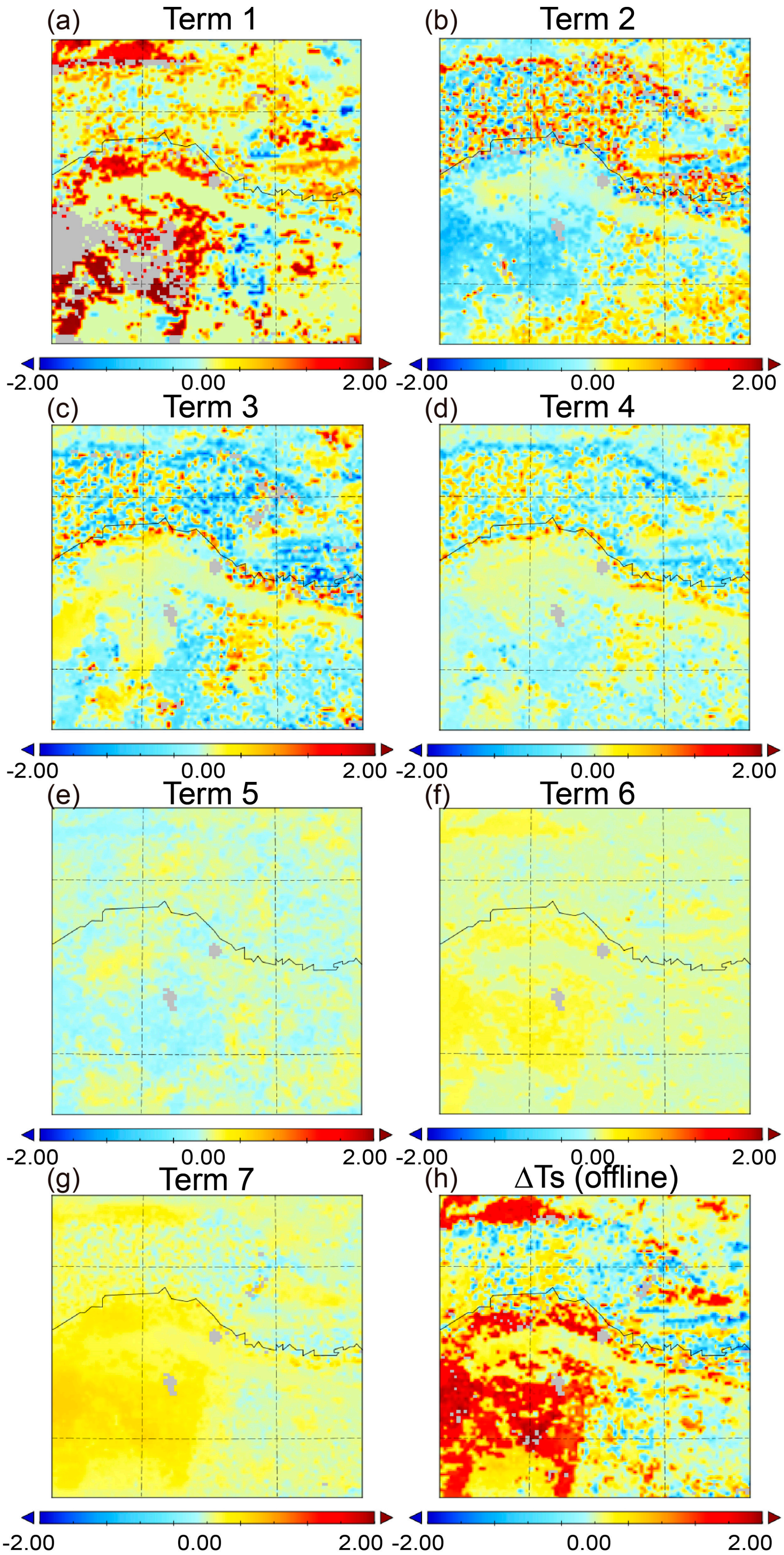

Figure S3. Partition of the daytime intrinsic biophysical effect and atmospheric feedback in summer according to the IBPM theory. (a) effect of albedo change, (b) energy distribution associated with changes in roughness, (c) energy distribution associated with changes in Bowen ratio and (d) effect of soil heat flux changes, (e) effect of incoming shortwave radiation change, (f) effect of incoming longwave radiation change, (g) air temperature related term, (h) ΔT_s calculated offline with the IBPM theory.

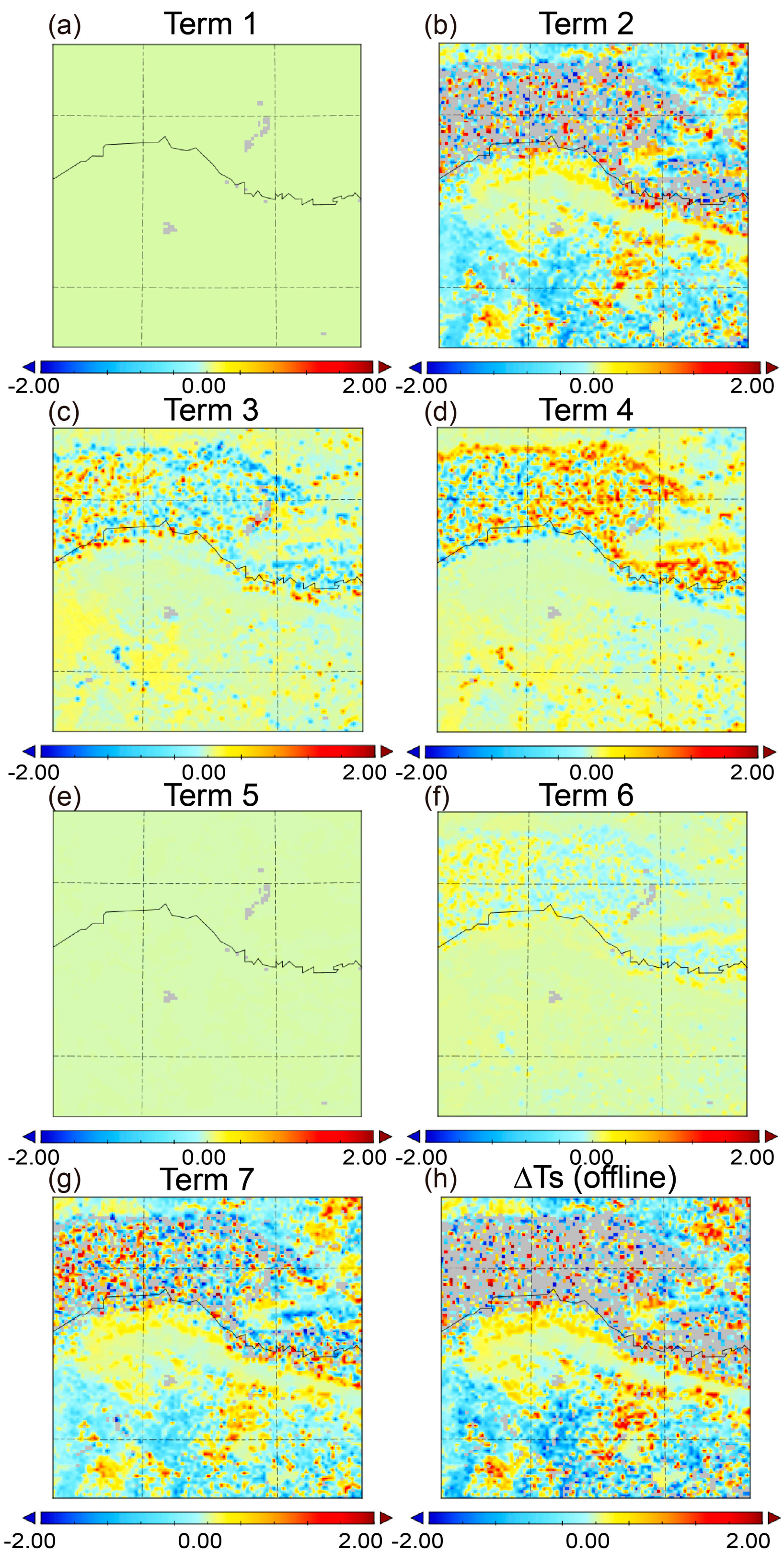

Figure S4. Partition of the nighttime intrinsic biophysical effect and atmospheric feedback in summer according to the IBPM theory. (a) effect of albedo change, (b) energy distribution associated with changes in roughness, (c) energy distribution associated with changes in Bowen ratio and (d) effect of soil heat flux changes, (e) effect of incoming shortwave radiation change, (f) effect of incoming longwave radiation change, (g) air temperature related term, (h) ΔTs calculated offline with the IBPM theory.

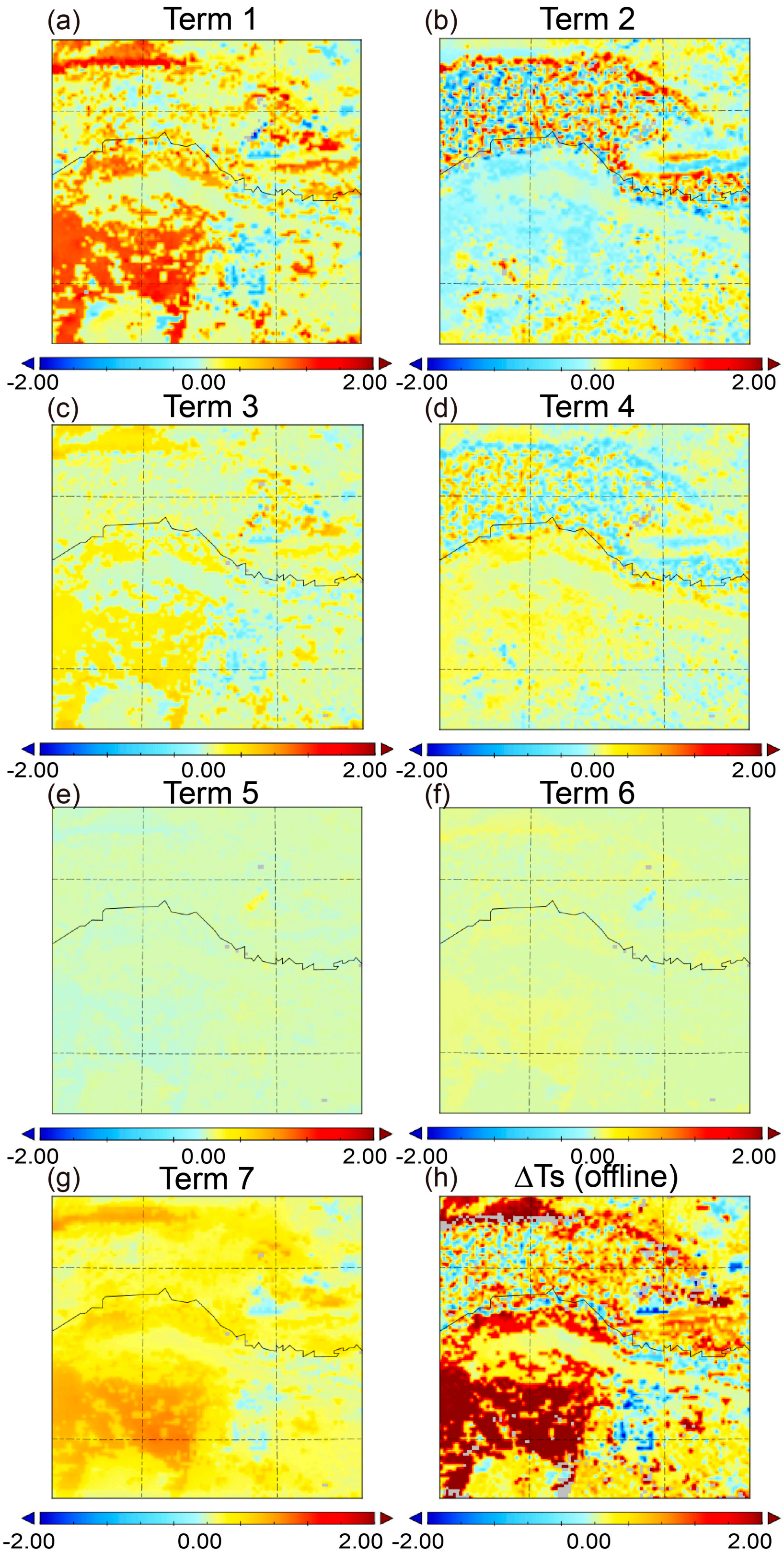

Figure S5. Partition of the daytime intrinsic biophysical effect and atmospheric feedback in winter according to the IBPM theory. (a) effect of albedo change, (b) energy distribution associated with changes in roughness, (c) energy distribution associated with changes in Bowen ratio and (d) effect of soil heat flux changes, (e) effect of incoming shortwave radiation change, (f) effect of incoming longwave radiation change, (g) air temperature related term, (h) ΔT_s calculated offline with the IBPM theory.

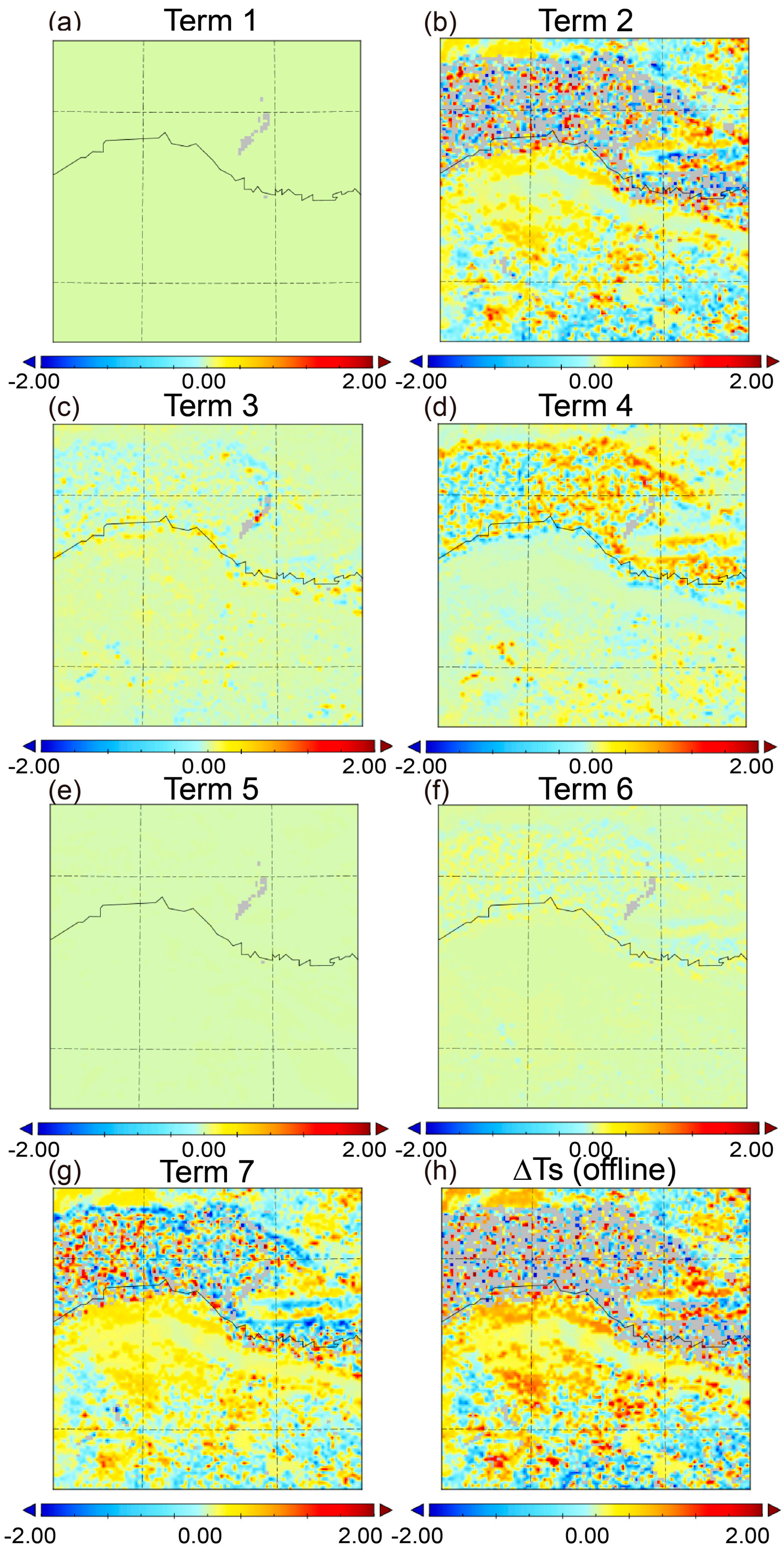

Figure S6. Partition of the nighttime intrinsic biophysical effect and atmospheric feedback in winter according to the IBPM theory. (a) effect of albedo change, (b) energy distribution associated with changes in roughness, (c) energy distribution associated with changes in Bowen ratio and (d) effect of soil heat flux changes, (e) effect of incoming shortwave radiation change, (f) effect of incoming longwave radiation change, (g) air temperature related term, (h) ΔTs calculated offline with the IBPM theory.